# FUEL RESISTANT SEALERS

## PART I: INTRODUCTION

### Background

1. A large number of asphalt concrete pavements are damaged each year due to the spillage of fuel onto these pavements. The fuel softens the asphalt binder and causes the asphalt concrete mixture to disintegrate and erode under traffic. Of prime concern is JP-4 fuel.

2. In order to prevent this damage due to fuel spillage, other pavement surfacings such as portland cement concrete (PCC) must be used or some technique to protect the asphalt concrete from fuel spillage must be provided. PCC pavements generally are more expensive; therefore, the use of bituminous pavements is desirable. In the past, tar and tar-rubber concrete pavements were used in fuel spillage areas; however, poor performance resulted in their use being discontinued. Also, the manufacture of tar-rubber has become increasingly difficult due to restrictions by the Occupational Safety and Health Administration (OSHA)

3. The use of fuel resistant sealers to protect the asphalt concrete from the adverse effects of fuel spillage is a desirable technique. These sealers are simple to apply and their use is more cost-effective than the previously mentioned options. Many sealers are on the market but few claim to be jet fuel resistant, and most lack documented information concerning their field performance.

### Objective

4. The objective of this study was to determine by laboratory tests the adequacy of a number of sealers to protect asphalt concrete mixtures from the adverse effects of fuel spillage (jet fuel) and to exterpolate this data to predict field performance.

### Scope

5. A number of companies were contacted and requested to furnish potential fuel resistant sealers for this study. These sealers were evaluated through a laboratory testing program to determine potential performance under fuel spillage conditions. The laboratory evaluation consisted of dripping fuel (Reference Fuel B, paragraph 13) on asphalt

concrete specimens that had been sealed, conducting an abrasion test to identify damaged specimens, and determining the weight loss after the abrasion test.

## PART II: PRODUCTS

6. The materials used for this project were selected from a previous study which evaluated the use of fuel resistant sealers or binders for porous friction courses (Shoenberger, 1983). The materials selected had generally shown good performance in this previous study. A description of each of the materials selected is provided in Table 1. The overall evaluation of the materials investigated included material cost, laboratory performance when subjected to fuel spillage, and ease of preparing laboratory specimens.

7. The cost of materials varied from approximately $1.00 to $19.00 per gallon (Table 2). For these costs to be meaningful, the application rate to protect an asphalt pavement from spillage and the expected life of the sealer would have to be determined. In other words, the material that cost $19.00 per gallon may be cheaper for a life cycle cost than the material that cost $1.00 per gallon.

8. There are many other materials available for use as jet fuel resistant sealers; however, it was felt that the ones selected are typical of most types of sealers.

## PART III: LABORATORY TESTING

9. A laboratory testing program was conducted to evaluate each of the seven products. Dense graded mixtures were prepared in the laboratory, sealed with each of the products being evaluated, and tested for effects of fuel spillage and abrasion. Table 1 contains a list and description of all products tested.

10. The asphalt concrete cores upon which the sealers were applied consisted of a bituminous wearing course mixture compacted in the

laboratory to approximately the expected field density. The cores were 6 ± 0.1 in. (50.8 ± 2.5 mm) in diameter and approximately 2 in. (5.1 mm) in height.

11. The asphalt cores were sealed on the side, top, and bottom. The materials were evenly applied to the test specimens with a 1.5-in, nylon brush. The specimens were initially sealed on all but the bottom and allowed to dry to a nontacky state. Then after inverting the specimen, the remaining side was sealed and this side became the test surface for all tests.

12. The curing time required was dependent upon the type of material used and was based on manufacturers' recommendations. An initial set (nontacky) was obtained within 24 hours at room temperature in all cases. The chem-crete, RT-14 and sulflex sealed specimens, although considered to be cured (nontacky) after 24 hours, were easily marked by fingerprints, etc. and hardened slowly for several days. Sulflex hardened at the slowest rate of all materials.

13. After the specimens were cured, they were subjected to a fuel drip test. In approximately 10 minutes, 1000 ml of reference Fuel B 70% Iso-octane + 30% toluene by volume), under a constant 5 psi pressure head, was dripped on each specimen tested. This fuel covered the entire specimen surface for the required time. The specimens were rotated 90 degrees every 2-1/2 minutes to help assure uniform coverage of fuel over the specimen surface. The specimens were placed on a wire mesh for the fuel tests to prevent the fuel from accumulating on the bottom of the specimen.

14. The abrasion test was run on all specimens within 5 minutes of completion of the fuel drip test. The abrasion test is an adaptation of the "wet track abrasion test", ASTM D 3910 (ASTM 1982). Two changes required to this method included shortening the abrasion hose from 5.0 in. to 1.5 in. and increasing the depth of the metal pan from 2.0 in. to 2.5 in. The shorter hose was required for use with the 6-in, specimens and the depth increase was to allow the specimens to be completely submerged in water. At the completion of the abrasion test, the specimens were allowed to dry to a constant weight or for 24 hours, whichever was shorter. This weight is recorded along with noting any loss of aggregate particles from the specimens. Whenever the material takes longer than 24 hours to obtain a constant weight, this signifies that fuel or water has penetrated the sealer. The two possible causes of fuel penetration are: (a) the specimen is not completely sealed, or (b) the fuel has softened the sealer and penetrated the specimen.

## PART IV: LABORATORY TEST RESULTS

15. The products tested covered several material types and varied greatly in effectiveness. The material was difficult to apply with a brush when the materials required heating before application. When heating was necessary, this generally required that a thick layer of sealer be applied to the asphalt concrete sample.

16. No. 21 epoxy is a two-part coal tar epoxy. As suggested by the Manufacturer, the mix ratio for laboratory testing was 1 part binder to 1 part activator by weight. The sealed specimen was subjected to two cycles of fuel dripping and abrasion. The specimen showed no distress during the fuel drip and abrasion tests and there was essentially no weight loss from the tests (Table 2).

17. Chem-Crete coal tar is a RT-12 tar modified by the Chem-Crete Corporation. This material could not be properly applied to the specimen cores with the brush. It was heated to 210$^0$F, but when it was applied by the brush it cooled quickly and could not be thinly spread which resulted in a thick coating. Then Chem-Crete coal tar did not bind to the specimen and could be easily be peeled from it. After the specimen was subjected to one cycle of fuel and abrasion, there was no visual damage to the specimen. There were several places where the sealer had broken away from the asphalt core and fuel could penetrate into the asphalt mix. The specimen developed hairline cracks over its entire surface once it had dried following the fuel drip and abrasion test. After testing, this material was considered unsatisfactory as a fuel resistant sealer.

18. Koppers coal tar emulsion (non-winterized) was applied full strength to a specimen. The intial fuel test did little damage, although the specimen which was originally black turned a brownish color. During the initial abrasion test, a small amount of the sealer was removed from the abraded surface. Five days later, a second fuel and abrasion test was conducted on the same specimen. The specimen failed in this second cycle of tests. There was a loss of asphalt and aggregate from the area of the specimen where the abrasion test was conducted. A soft spot also developed in the bottom of the specimen where fuel apparently entered and leached out asphalt from the core.

19. Koppers coal tar emulsion (winterized, contains antifreeze) was applied to a specimen after being diluted with an equal amount of water. The specimen which was cured for 24 hours before testing failed after one cycle of fuel and abrasion. During the fuel drip test, the fuel appeared to dissolve and remove a large amount of sealer and/or asphalt. Abrasion removed a small amount of aggregate and left a rough

exposed surface where the abrasion occurred.

20. Koppers coal tar super seal emulsion was applied undiluted to a specimen in four coats over two days time to obtain the desired sealer thickness. This coal tar emulsion contains 3 percent rubber by weight of coal tar. The specimen was subjected to two cycles of fuel and abrasion. The amount of material removed during the fuel tests was minimal. The abrasion tests did little damage to the surface of the specimen.

21. Koppers RT-14 is a paving grade road tar. The material was heated to 225°F (107.2°C) for application to the specimen. This material which acted similar to the Chem-Crete coal tar could not be properly applied to the asphalt cores. The applied coating was too thick and the material did not adhere satisfactorily to the specimen. The specimen was subjected to one cycle of the fuel and abrasion tests with no visible damage occurring to the sample. This material was considered unsatisfactory as a sealer because it would not properly coat the asphalt mix.

22. Sulflex 233 is a plasticized sulfer material. Difficulty was encountered in sealing the core specimen with the Sulflex as observed with the Chem-Crete coal tar and Koppers PT-14. The Sulflex was heated to 280°F (137.8°C) for application to the specimen. A heavy coating of the material had to be applied and it hardened very slowly, remaining soft to the touch up to 48 hours after application. The material was tested 24 hours after application by one cycle of fuel and abrasion. The tests performed had no apparent effect on the specimen. This material was considered unsatisfactory as a sealer; however, because of difficulty in coating the specimen.

23. An unsealed specimen core had a fuel drip test performed on it as a comparison to the sealed specimen. The fuel leached out the asphalt binder during the fuel drip test and the sample disintegrated prior to conducting the abrasion test.

## PART V: FIELD APPLICATIONS

24. Although no tests were conducted in the field to verify the laboratory test results, a brief discussion of expected performance is presented.

25. All of the materials investigated with the exception of No. 21 epoxy can be applied with a conventional asphalt distributor. There are distributors available that can apply epoxies. This equipment must have a chamber for each of the two components and be designed to mix the components in the proper proportion when spraying.

26. Based on laboratory test results three of the materials investigated (Chem-Crete tar, Koppers RT-14, and Sulflex) would be difficult to properly apply in the field. These materials must be heated to relatively high temperatures in order to properly spray and when these materials are sprayed onto the pavement, they cool quickly and do not evenly cover the pavement surface. Even though these materials are fuel resistant, they cannot be used as a sealer.

27. The four materials investigated that can be properly sprayed onto the pavement surface are the three tar emulsions and Product No. 21. The winterized coal tar emulsion which was diluted before application to the asphalt core did not perform satisfactory in the laboratory. It is believed however that a thicker application of this material could result in improved performance. Until further laboratory tests are conducted, it is not recommended for field testing.

28. This study did not evaluate the durability of the various materials; however, from a resistance to fuel point of view, the product No. 21 clearly outperformed the other materials. Based on this limited laboratory study, it appears that the use of tar emulsion sealer would require more applications than Product 21 throughout the life of a pavement.

29. Regardless of what material is used, it is necessary that an asphalt pavement which is going to be subjected to fuel spillage be

sealed with a fuel resistant material prior to fuel spills. Once the damage to the asphalt mixture has occurred, a sealer helps very little, unless the asphalt mixture is still structurally sound and is properly cleaned before sealing.

## PART VI: CONCLUSIONS

30. The Product No. 21 performed very well in the laboratory and should provide satisfactory performance in the field.

31. Tar emulsion resisted the effects of fuel to some extent; however, the fuel gradually dissolved the tar. Those materials which are relatively inexpensive (approximately $1.00/gallon) may be used; however, periodic applications would be required.

32. RT-14, Chem-Crete tar, and Sulflex are fuel resistant; however, spraying and handling techniques make them impractical for use as a fuel resistant sealer.

## PART VII: RECOMMENDATIONS

33. There is a need to evaluate fuel resistant sealers in the field so that cost and performance data for various materials can be analyzed to determine which sealers would provide the most cost-effective solution to the fuel spillage problem on asphalt concrete pavements.

34. This will be accomplished as part of the Facilities Technology Applications Test Program that will commence in FY 84.

REFERENCES

1. Shoenberger, J. E., 1983, “Fuel Resistant Porous Friction Surface,” unpublished report, USAE Waterways Experiment Station, CE, Vicksburg, Miss.

2. ASTM, 1982, “Standard Practices for Design, Testing, and Construction of Slurry Seal,” Designation D 3910-80a, 1982 Annual Book of ASTM Standards, Part 15, Philadelphia, Penn.

Table 1

Products Tested as Fuel Resistant Pavement Sealers

| Product | Manufacturer | Material | Mixture | Application rate Gal/yd$^2$ | Price per Gallon | † Approximate Price per Square Yard |
|---|---|---|---|---|---|---|
| No. 21 epoxy | American Protective Coating Corp. Cleveland, Ohio | Coal gar epoxy | *1 part binder to 2 parts activator | 0.1 | $18.52 | $1.85 |
| Tar | Chem-Crete Corp. | Tar | None required | 0.2 | >$ 2.00 | $ .40 |
| Coal tar emulsion (non-winterized) | Koppers Inc. Pittsburgh, PA | Coal tar emulsion | No water added | (.1 to .3) 0.2 | $ .92 | $ .18 |
| Coal tar emulsion (winterized) | Koppers, Inc. Pittsburgh, PA | Coal tar emulsion | 1 part emulsion to 1 part water | 0.4 | $ .92 | $ .18 |
| Super Seal coal tar emulsion | Koppers Inc. Pittsburgh, PA | Coal tar emulsion with rubber | No water added | 0.2 | $ .95 | $ .19 |
| RT-14 | Koppers Inc. Pittsburgh, PA | Tar | None required | 0.2 | >$ 2.00 | $ .40 |
| Sulflex 233 | Southwest Research Institute, San Antonio, Texas | Plasticized Sulfer | None required | 0.2 | ** | |

* The manufacturer now suggests a 1 to 1 mixture.
** No price available but probably $3.00 to $4.00 per gallon.
† These price estimates are not directly comparable due to unknowns concerning the life of the sealers.

Table 2

Fuel Resistant Pavement Sealers

| Product | Original Weight of Sample | Weight After Sealing | Weight of Material Applied | Weight After First Cycle | Weight After Second Cycle | Remarks |
|---|---|---|---|---|---|---|
| No. 21 Exoxy | 2257.8 | 2273.0 | 15.2 | 2273.2 | 2272.8 | Specimen received two fuel drip tests before first abrasion test. |
| Chem-Crete** processed coal tar | 2250.2 | -- | -- | -- | -- | Weight not recorded; fuel penetrated specimen where sealer separated from core. |
| Koppers coal tar emulsion (non-winterized) | 2247.8 | 2259.2 | 11.4 | 2258.2 | 2191.0 | Some material removed by abrasion head. |
| Koppers coal tar emulsion (winterized) | 2271.0 | 2282.6 | 11.6 | 2196.8 | -- | Failed after one cycle. |
| Koppers* coal tar super seal emulsion | 2256.5 | 2288.2 | 26.3 | -- | 2294.1 | Applied in four coats; test surface marked or indented by abrasion head. |
| RT-14** | 2234.8 | 2325.3 | 90.5 | 2325.6 | -- | No apparent damage to specimen after testing. |
| Su flex 2≥≥** | 2244.8 | 2342.9 | 98.1 | -- | -- | Weight not recorded; fuel penetrated specimen where sealer separated from core. |
| Untreated specimen | 2225.5 | -- | -- | Failed | | During abrasion test aggregate dislodged from surface and test ended. |

* Contains 5 percent rubber by weight of coal tar.

** These products had to be heated for application. The application technique used (brushing prevented a satisfactory sealing of the specimens, except by obtaining extremely thick coatings.